Integrating the Methods of Project-Based Learning and Role-Playing to Promote Deep Approach of Learning: Programming Languages

Emergent Research Forum Paper

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Abstract

In recent years, there has been an increasing amount of literature on critical thinking and deep learning. Conversely, the traditional pedagogical methods of teaching lack the potentiality to make deep learning especially for the practice-oriented courses such as programming languages. Thus, this study is designed based on the Project-Based Learning (PBL) and Role-Playing (RP) which are integrated to enhance deep learning for the programming languages course. PBL gives the students control of their work in both a literal and figurative sense. On the other hand, RP plays a complementary part to assist teaching and assess the learners' motivation, satisfaction, and learning achievement. Therefore, the curriculum content is mapped into the designed project and roles to provide a scenario learning environment. Hence, this research for learners will be beneficial to teach and reinforce skills that prepare learners for their future careers, such as collaboration, problem-solving, creativity, and communication.

Keywords

Project Based Learning, Role-Playing, Deep learning, Programming Languages.

Introduction

Effective and efficient teaching is a skill that comprises factors as education, experience, training, and ability. According to the concept of teaching, it is the knowledge taught to students who need to be tutored in the practical matters that will help them advance in their chosen field. Consequently, teaching could be a guide that can help keep the focus of educational practice in developing the deep understanding of learners (Entwistle 2003; Archer and Hughes 2011; Light et al. 2009).

In 2003 Ramsden demonstrated several features of deep and surface approaches in the context of academic studying which are considered in this project to improve a deep approach. The Structure of Observed Learning Outcomes (SOLO) taxonomy describes the level of increasing complexity in a student's understanding of a subject, through different levels of thinking (Biggs and Collis 1982). It encourages students to think about where they are currently in their learning, and what they need to do in order to progress. Thus, this project will be useful to motivate learners via teaching activities. We've tried to use SOLO taxonomy to frame the learning via Project-Based Learning (PBL) and Role-Playing (RP). To adopt the SOLO taxonomy as a theory of learning, it makes sense to use Figure 1 and Table 1 as the basis for assessing the learning.
Integrating the PBL and RP

Figure 1. A hierarchy of verbs that may be used to form intended learning outcomes (Biggs and Tang 2011)

<table>
<thead>
<tr>
<th>Level of Learning</th>
<th>SOLO Taxonomy</th>
<th>Verbs for Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface-</td>
<td>Unistructural</td>
<td>Memorize, identify, recognize, count, define, draw, find, label, match, name, quote, recall, recite, order, tell, write, imitate</td>
</tr>
<tr>
<td>Foundation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface-</td>
<td>Multistructural</td>
<td>Classify, describe, list, report, discuss, illustrate, select, narrate, compute, sequence, outline, separate</td>
</tr>
<tr>
<td>Developing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep-</td>
<td>Relational</td>
<td>Apply, integrate, analyze, explain, predict, conclude, summarize (précis), review, argue, transfer, make a plan, characterize, compare, contrast, differentiate, organize, debate, make a case, construct, review and rewrite, examine, translate, paraphrase, solve a problem</td>
</tr>
<tr>
<td>Secure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep-</td>
<td>Extended</td>
<td>Theorize, hypothesize, generalize, reflect, generate, create, compose, invent, originate, prove from first principles, make an original case, solve from first principles</td>
</tr>
<tr>
<td>Excellence</td>
<td>abstract</td>
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</tr>
</tbody>
</table>

Table 1. SOLO Taxonomy and Level of Learning (Biggs and Tang 2007)

PBL will be useful to motivate the learners, which they are involved in the entire process of the identified projects, from conception to completion. Hence, students will typically be assigned a specific project that requires them to use various skills such as programming, researching, writing, interviewing or collaborating to design and develop a project, such as design software, or a database that are relating to this project. They ask original questions, research topics that interest them, and complete projects of their choosing (Barron et al. 1998; Gregory and Kaufeldt 2015).

According to PBL, learners can understand the areas of real-world projects which are related to the design, modeling, and implementation of software through a programming language for instance. Therefore, PBL makes university more engaging for students; improves learning; builds success skills for higher education, career, and life; helps address standards; provides opportunities for students to use technology; makes teaching more enjoyable and rewarding and connects students and universities with communities and the real world (Bell 2010; Krajcik and Blumenfeld 2006).

The causes of PBL learning as motivational have been investigated (Blumenfeld et al. 1991). Hence, PBL is focused on teaching by engaging students in an investigation. Consequently, students can learn deeply via asking and refining questions, debating ideas, making predictions, designing plans and/or experiments,
collecting and analysing data, drawing conclusions, communicating their ideas and findings to others, asking new questions, and creating artefacts (Blumenfeld et al. 1991; Dolenc et al. 2016).

In 2004, Sogunro published a paper in which he described the need to deep learning and critical thinking for the leaders. He stated that the method of RP has presented itself as one of the most promising training techniques today and it differs in many unique ways in order to transform theoretical concepts into an experiential format. Based on the RP, the students can play a role to become anyone else for a specific time. It is a kind of imaginary and simulation of various situations. Hence, different concepts within defined scenarios can be activated and practiced through this method.

According to Van Ments (1989), “No matter how much reading and observing the student undertakes, the only way to develop these skills fully is by using them in actual interpersonal situations. The interplay of verbal and non-verbal behavior is far too complex and subtle to be reduced to a few simple rules”.

On the other hand, in 2016, Svensson and Regnell demonstrated that RP is in requirements engineering education for increasing the learning outcomes. Based on the literature review of RP as a pedagogical tool has been used in many disciplines such as nursing, medicine, engineering, management, and consultancy settings (Svensson and Regnell 2016). Hence, playing a role or several roles provide the possibility of deep learning that allows students to achieve experience in that field.

A major problem with applying PBL is choosing an unsuitable and unplanned project representing the main assignment or activity of a course. It means that some of the projects are not interesting for the students or are not appropriate because of the level of quality and quantity (very low or very high). Some of them are proposed at the end of the class as usual as the traditional methods of teaching. On the other hand, based on the previous methods, identification of the students’ understanding of the course information could be difficult for lecturers. Hence, these situations could lead to the lack of motivation and cause dissatisfaction.

The main research objective is “To integrate the methods of PBL and RP as a web-based application to promote the deep approach of learning in programming languages”. This understanding could be achieved through these objectives which are listed as below.

1) To integrate the methods of PBL and RP to promote the deep approach of learning in programming languages.
2) To develop a web-based application.
3) To analyze the learning motivations and learning outcomes.

Therefore, in this research, a solution will be presented to describe how the integrated method of PBL and RP as a web-based application can motivate students to promote the deep approach to learning.

**Concepts in Programming Languages**

Programming Languages as a mandatory course is intended for bachelor students of Software Engineering. The course covers the basic concepts related to the design and implementation of high-level programming languages. The course stresses underlying theoretical concepts as well as a significant, practical course project. Hence, this is not an introduction to programming; students should already know how to program, preferably in at least couple of languages.

Therefore, students write Ruby, JavaScript, Python, Haskell and Objective CAML code and gain experience with functional and object-oriented programming. Students also write a small number of C and almost-Java programs.

The programming assignments and a project in this course lead to the construction of an interpreter for a subset of Java are proposed based on the integration of PBL and RP. The proposed model in this course involves stages of scanning, parsing, type-checking and interpreting code. Hence, the concepts such as context-free grammars, variable bindings, control flow; types, subtyping, and method invocation are covered in this course (Carr 2014; King 1992).
Learning Outcomes

According to this project, an integrated method will be proposed for the programming languages in order to achieve the following Learning Outcomes.

Knowledge and understanding

1. Be able to describe the basic concepts behind programming languages, with an emphasis on the techniques and benefits of functional programming.
2. Be able to illustrate the real challenges of the programming techniques.

Skills and abilities

3. Be able to write a program in order to learn how the pieces of a language fit together.
4. Be able to collaborate and communicate with one another in order to improve group activities, solve problems and knowledge sharing.

Critical judgment and evaluation

5. Be able to apply the concepts and design principles relating to data structures, computer architecture and organization, programming languages, operating systems, and networks.
6. Be able to examine the functionality of the program and use a test plan during the testing phase.

Research Methodology

According to the prototyping methodology, the project will be conducted in the followings phases which are (1) Research, (2) Planning, (3) Design, (4) Prototype, (5) Feedback, (6) Development, (7) Testing, (8) Setup, and (9) Maintenance. Prototyping is an attractive idea for complicated and large systems for which there is no manual process or existing system to help to determine the requirements. In such situations letting the client plan with the prototype provides invaluable and intangible inputs which help in determining the requirements for the system. It is also an effective method to demonstrate the feasibility of a certain approach. This might be needed for novel systems where it is not clear (Cooling and Hughes 1989). The process model of the prototyping approach is shown in Figure 2 below.

![Figure 2. Prototyping methodology (Cooling and Hughes 1989)](image)

Phase 1, 2 and 3, is related to initial study of this project, because of this, it includes of observation the previous studies, articles, journals, conferences for understanding about the last activities that are done to appoint the basic of the research, observe the problem areas and identify the current problem within the learning and teaching of programming languages.

Consequently, Hyper Text Markup Language (HTML), Cascading Style Sheets (CSS), JavaScript, Personal Home Page/ Hypertext Preprocessor (PHP) and Structured Query Language (SQL) using MySQL will be used to building a demo version of the web-based application that includes the critical functionality in Phase 4 and Phase 6 as a development phase.

Therefore, the application will be evaluated technically and theoretically through Phase 5 & 7. Hence, in order to evaluate the effectiveness of their learning and how the users feel about the application, the students will be asked to test curriculum contents and complete a questionnaire. Thus, in the collected questionnaire data, reliability and validity of the questionnaire will be assessed. Then, ANOVA, T-test and Regression analysis will be applied to analyze whether the achievement of the proposed application has achieved. Finally, Theory of Planned Behavior (TPB) will be used to understand the motivation to learn.
Conclusion

Thus, this study proposed an integrated method and the benefits of using it to improve a deep approach to learning. Therefore, based on this application, educators can observe a student’s sequence of actions, time spent on tasks, multiple attempts at activities, requests for help, communication process, and so on. These situations cause the students to achieve the expected learning outcome, correctly. The use of the proposed integrated method as an innovative teaching strategy could be valuable in software programming education.

REFERENCES


